

## Cheilostomatous Bryozoa from the Kurile Islands and the Neighbouring Districts<sup>1</sup>

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ABOUT A DOZEN YEARS have elapsed since Dr. Katsuzo Kuronuma very kindly placed his collection of Bryozoa from Kurile Islands at my disposal. Though I presented a preliminary report at the seventeenth annual meeting of the Zoological Society of Japan, the large part of my study on northern forms has been put away unpublished.

There have been only two papers published on the bryozoan fauna of the high north-western Pacific, both by Dr. Y. Okada. In 1918 he described 10 species from Dr. H. Marukawa's collection from Kamtschatka, and later (1933) he published a brief account of 14 species collected by the Northern Kurile Expedition of the Biogeographical Society of Japan. Our knowledge of the bryozoan fauna of these districts remains, therefore, very incomplete at present. To prepare this brief report, then, I have made a thorough re-examination of the northern material both in Okada's possession and my own.

### *Specimens*

1. From Kamtschatka, collected at spots near the estuary of the River Kishika by Dr. H. Marukawa, June 1912. Nos. 560-580.

<sup>1</sup> Contributions from the Research Institute for Natural Resources. No. 729. Studies on the Bryozoan Fauna of Japan and Adjacent Waters. No. 2. Manuscript received March 31, 1955.

<sup>2</sup> The Research Institute for Natural Resources, Shinjuku, Tokyo, Japan.

2. Taken by the Northern Kurile Expedition of the Biogeographical Society of Japan, collected by Mr. K. Koba in 1931.  
Off Ichinowatashi, Alaid Island. Nos. 1400-1412.  
Kitaura, Alaid Island Nos. 1413-1415.  
Off Arakawa, Paramushir Island. Nos. 1416-1420.  
Torishima, Paramushir Island. Nos. 1421-1438.
3. From Paramushir Island, collected by Dr. K. Kuronuma at a spot 10 miles south of the Island, August 1942. Nos. 4000-4021.
4. A part of the following material from Hokkaido.  
Akkeshi, coll. by Iwasa, July 1938. Nos. 1200-1221.  
Samani, coll. by Kuronuma, March 1944. Nos. 4200-4218.  
Akkeshi, coll. by Tanaka, August 1944. Nos. 4219-4251.  
Akkeshi, coll. by Okada, July 1945. Nos. 4508-4519.  
Kushiro, coll. by Nagamine, July 1950. Nos. 6201-6367.

Study of these collections has shown 45 species (including 2 undetermined forms) belonging to 15 families and 32 genera to be present. Six of the species are described as new. The known distribution of the species included is given in Table 1. In spite of the



fact that the materials have been obtained from somewhat confined localities and consequently they cannot provide a sufficient basis for a full discussion of the bryozoan fauna of these districts, the table will give a general idea of the faunistic constitution of the high northwestern Pacific.

Excluding two uncertain forms and 12 restricted species, 27 of the remaining 31 are known to occur in the Arctic Ocean or in the northern part of the Atlantic, thus indicating the overwhelming influence of colder waters on the fauna of this district. It may be rather surprising that only three of the species belong to the circum-pacific group.

I should like to express here my cordial thanks to Drs. Y. Okada and K. Kuronuma who have given me an opportunity to examine their interesting collections.

The figures have been drawn with the aid of a camera lucida at magnifications of 50 or 200 diameters.

## A N A S C A

### Family *AETEIDAE*

#### 1. *Aetea anguina* (Linnaeus), 1758

Fig. 1a

Zoarium adherent, occasional by branching. Zooecia elongate, creeping, granulated proximally; erect, tubular, curved, annulate distally. Membranous area subterminal, slightly expanded, punctured dorsally. An empty membranous ovisac was observed on the frontal membranous area near the distal end.

SPECIMENS EXAMINED: No. 4011 (Paramushir), No. 4221 (Akkeshi), Nos. 6238, 6317 (Kushiro).

### Family *MEMBRANIPORIDAE*

#### 2. *Membranipora serrilamella* Osburn, 1950

Fig. 1b

Zoarium encrusting especially on wider algae. Zooecia nearly elongate-quadrangular,

with thick walls and serrate cryptocyst, sometimes a longer spinule at the proximal end. A small hollow protuberance at each corner. Several specimens were obtained from the floating fronds of kelp.

SPECIMENS EXAMINED: No. 4013 (Paramushir), No. 4227 (Akkeshi), Nos. 6211, 6325 (Kushiro).

#### 3. *Membranipora serrulata* (Busk), 1881

Colony erect, bilamellar, sometimes *Steganoporella*-like, rising from widespread unilamellar encrusting base. Zooecia variable in size, rectangular or elongate oval, with slight, granulate proximal cryptocyst, serrate marginally. Zooecial orifice rather large, subquadrangular. No spines, no avicularia and no ovicells. Two distal and two lateral rosette-plates. A pair of distinct opercular glands.

SPECIMENS EXAMINED: No. 566 (Kamtschatka), No. 6318 (Kushiro).

#### 4. *Conopeum reticulum* (Linnaeus), 1767

Fig. 1e

Zoarium encrusting especially on broader algae, greyish white, thin, often gauze-like. Zooecia, variable, elongate quadrangular or hexagonal, separated by grooves or lines. Walls thickly calcified, high, smooth or denticulate. Cryptocyst narrow, descending, granulate, surrounding oval, elliptic or circular opesia. A pair of triangular knob-like spaces, depressed or closed, on the proximal corners of short gymnocyst. Irregular rounded spaces sometimes scattered. Ooecia and avicularia wanting.

SPECIMENS EXAMINED: No. 1405 (Alaid), No. 4019 (Paramushir), No. 4233 (Akkeshi), No. 6235 (Kushiro).

### Family *ELECTRINIDAE*

#### 5. *Electra crustulenta* var. *arctica* (Borg), 1931

Fig. 1d

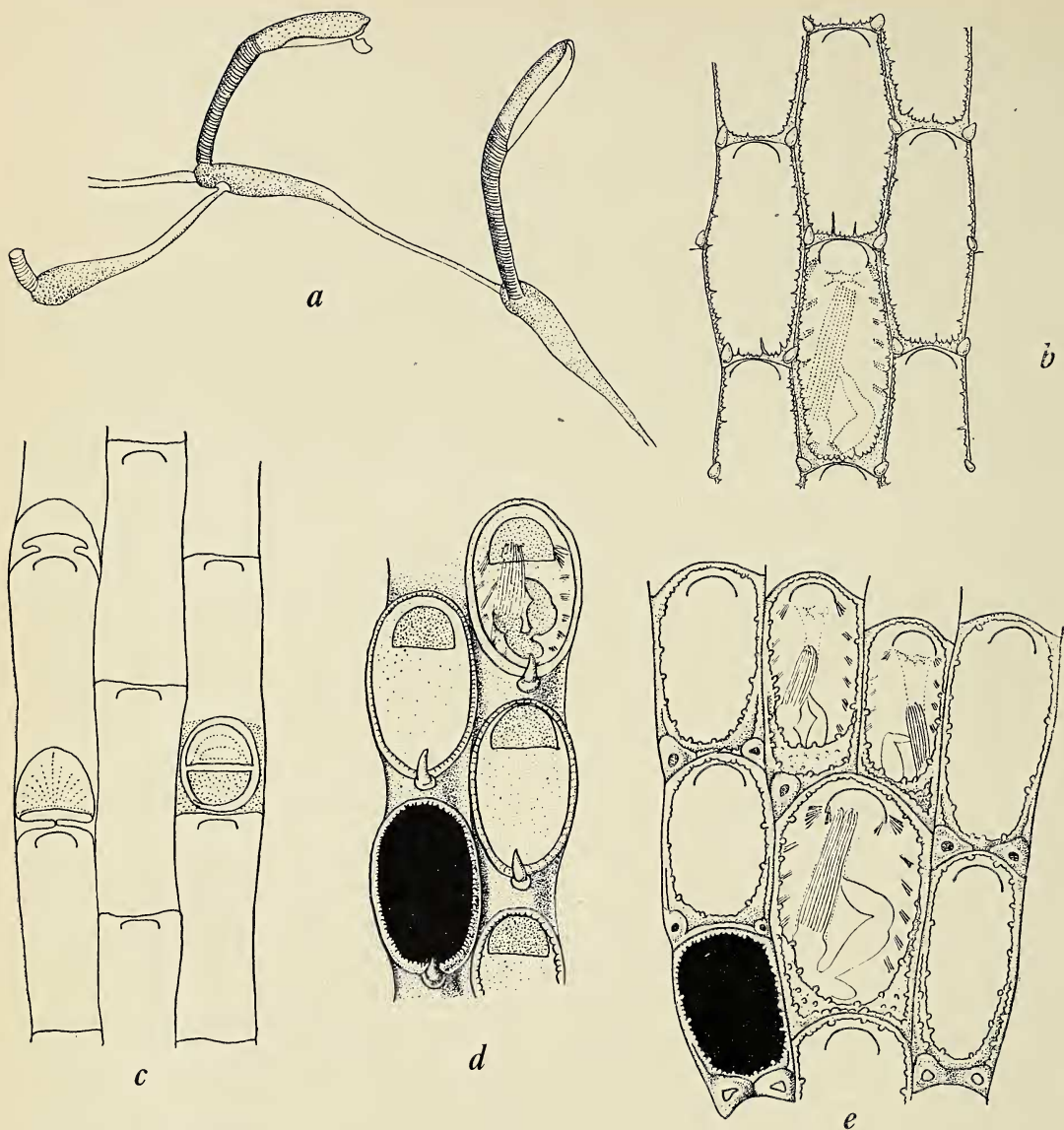


FIG. 1. *a*, *Aetea anguina* (Linnaeus); part of a creeping colony. *b*, *Membranipora serrilamella* Osburn; frontal view of zoecia with covering membrane. *c*, *Seculiflustra seculifrons* (Pallas); frontal view of zoecia, an interzoecial avicularium and two developing oecia. *d*, *Electra crustulenta* var. *arctica* (Borg); zoecia with large calcified operculum. *e*, *Conopeum reticulum* (Linnaeus); frontal view of zoecia.

Zoarium encrusting, thin. Zoecia elliptical, separated by furrows, with thickened, granulate mural rim and vestigial cryptocyst. Gymnocyst smooth, developed, with a single strong spinous process rising just proximal to the opesia. Operculum calcified, white.

Several specimens were obtained on shells and stones, they are easily distinguished by the calcified operculum and proximal process.

SPECIMENS EXAMINED: No. 1434 (Paramushir), Nos. 6215, 6217, 6336, 6341 (Kushiro).

Family *FLUSTRIDAE*6. *Seculiflustra seculifrons* (Pallas), 1766

Fig. 1c

Zoarium erect, frondose, rather narrow, truncate terminally. Zooecia elongate-quadrangular or elongate-hexagonal, simple, without spines. Avicularia vicarious, rectangular basally, subcircular or oval in frontal view. Mandibles semi-elliptical, deep yellow.

Ooecia immersed, oval, with radially striated frontal, closed with overarching lateral ribs.

SPECIMENS EXAMINED: No. 569 (Kamtschatka), No. 6281 (Kushiro).

7. *Terminoflustra membranaceo-truncata* (Smitt), 1867

Zoarium erect, unilaminar, thin, irregularly flabellate. Zooecia elongate hexagonal, truncate, with a minute spine at each distal corner. Avicularia square, mandibles semicircular. Ooecia endozooecial, small.

SPECIMENS EXAMINED: No. 1416 (Paramushir), No. 6201 (Kushiro).

Family *HINCKSINIDAE*8. *Hincksina onychocelloides* sp. nov.

Fig. 2a-c

Zoarium encrusting, thin, coarse, irregular, dark brown. Zooecia oval or hexagonal, arranged alternately in radiating rows. Frontal membrane occupies the whole front bordered with thin, granulate, inclined walls and narrow marginal cryptocyst. Operculum (Fig. 2c) rather thickened marginally, low, transverse. Vicarious avicularia occurring in longitudinal rows, elongate-elliptic, without bar and conspicuous teeth. Mandible (Fig. 2b) elongate-triangular, with proximally bifurcate long median sclerite extending terminally beyond the membranous wing, similar to that of *Onychocella*. A single distal and two lateral rosette plates. Minute spinous processes on the dorsal wall, probably for attachment.

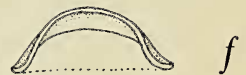
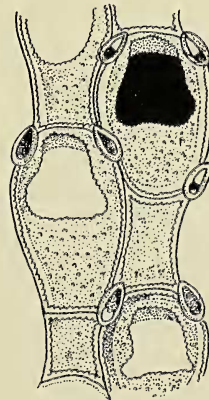
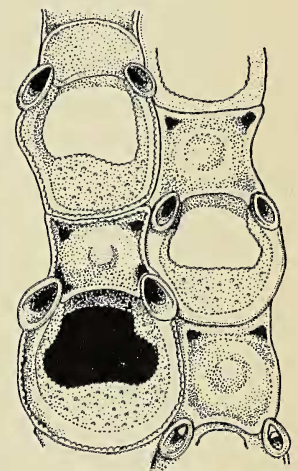
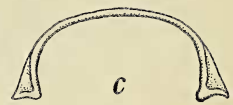
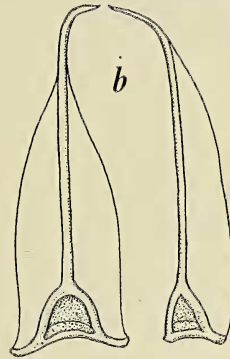
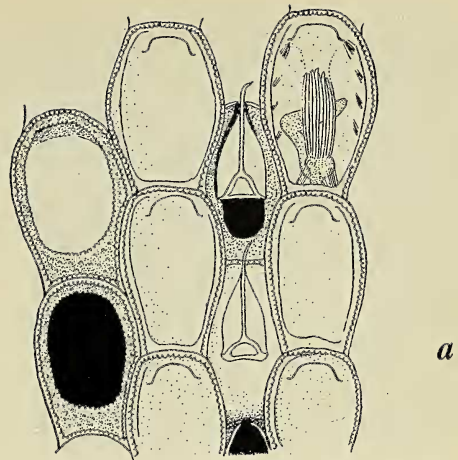


FIG. 2. a-c, *Hincksina onychocelloides* n. sp.: a, Frontal view of zooecia and two vicarious avicularia; b, avicularian mandibles with wings and produced median carina; c, operculum. d-g, *Antropora japonica* (Canu and Bassler): d, Frontal view of fertile zooecia with ooecia covering the interspecies spaces; e, young zooecia; f, operculum; g, delicate mandibles of dependent avicularia.

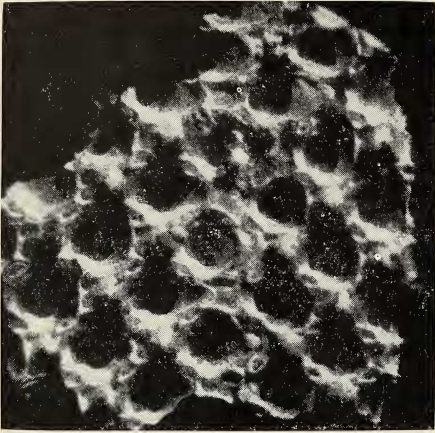


FIG. 3. *Antropora japonica* (Canu and Bassler), photomicrograph of calcined specimen.

This species is peculiar in having very wide opesia and *Onychocella*-type avicularian mandibles. It is somewhat doubtfully placed under *Hincksina*.

SPECIMENS EXAMINED: No. 4209 (Paramushir), Nos. 1206, 4223, 4513 (Akkeshi).

9. *Antropora japonica* (Canu and Bassler), 1929

Figs. 2*d*-*g*, 3

*Membrendoecium japonicum* Canu and Bassler (1929).

Zoarium encrusting, flat, irregularly lobate. Zooecia oval, hexagonal or quadrangular, very large, completely covered by brownish membrane. Frontal surrounded by thick, raised, granulate walls. Cryptocyst developed proximally, extending along the lateral walls, minutely granulate. Opesia nearly trifoliate, large, characteristic. Avicularium on a thickened protuberance at each distal corner, with pointed rostrum and delicate triangular mandible (Fig. 2*g*). Peculiar quadrangular interopesial area covered by membrane with or without separating walls. Fertile zooecia (Fig. 2*d*) larger and broader, with developed cryptocyst. Ooecium distinct, globose, umbonate,

situated commonly on the quadrangular interopesial space. A single terminal pore-chamber with four multiporous rosette plates, and two pairs of lateral pore-chambers with multiporous rosette plates. Opercular valve (Fig. 2*f*) low and broad.

The type locality is near Cape Tsugaru (misprinted as Tsiuka). The species is to be classified in *Antropora* not in *Membrendoecium*.

SPECIMENS EXAMINED: Nos. 4005, 4006 (Paramushir).

10. *Cauloramphus spiniferum* (Johnston), 1838

Fig. 4*a*

Zoarium encrusting stones or shells. Zooecia moderately large, with raised gymnocyst. Opesia oval or elliptic. Cryptocyst slight, sometimes vestigial. Opesial spines moderate; 10 to 13 in number, overarching the opesia. A small pedicellate avicularium with minute mandible among spines on each side, but slightly outside of the row of spines. Ooecium probably wanting.

SPECIMENS EXAMINED: No. 4021 (Paramushir), No. 4201 (Samani), Nos. 6209, 6256 (Kushiro).

11. *Callopora lineata* (Linnaeus), 1768

Fig. 4*b*

Zoarium encrusting, unilaminar, irregular, brownish. Zooecia distinct, oval, with raised walls. Frontal membranous area reduced, gymnocyst developed proximally. Opesia oval, a little broadened proximally, with thickened margin. Opesial spines, three or six on each side, obliquely overarched. Cryptocyst very narrow, linear and granulate. A triangular, suboral avicularium usually on a prominent globular umbo. Ooecia large, globose, flattened frontally, always traversed by thickened rib, and usually surmounted by an avicularium.

SPECIMENS EXAMINED: No. 571 (Kamtschatka), No. 4001 (Paramushir), No. 4208 (Samani), No. 4229 (Akkeshi).

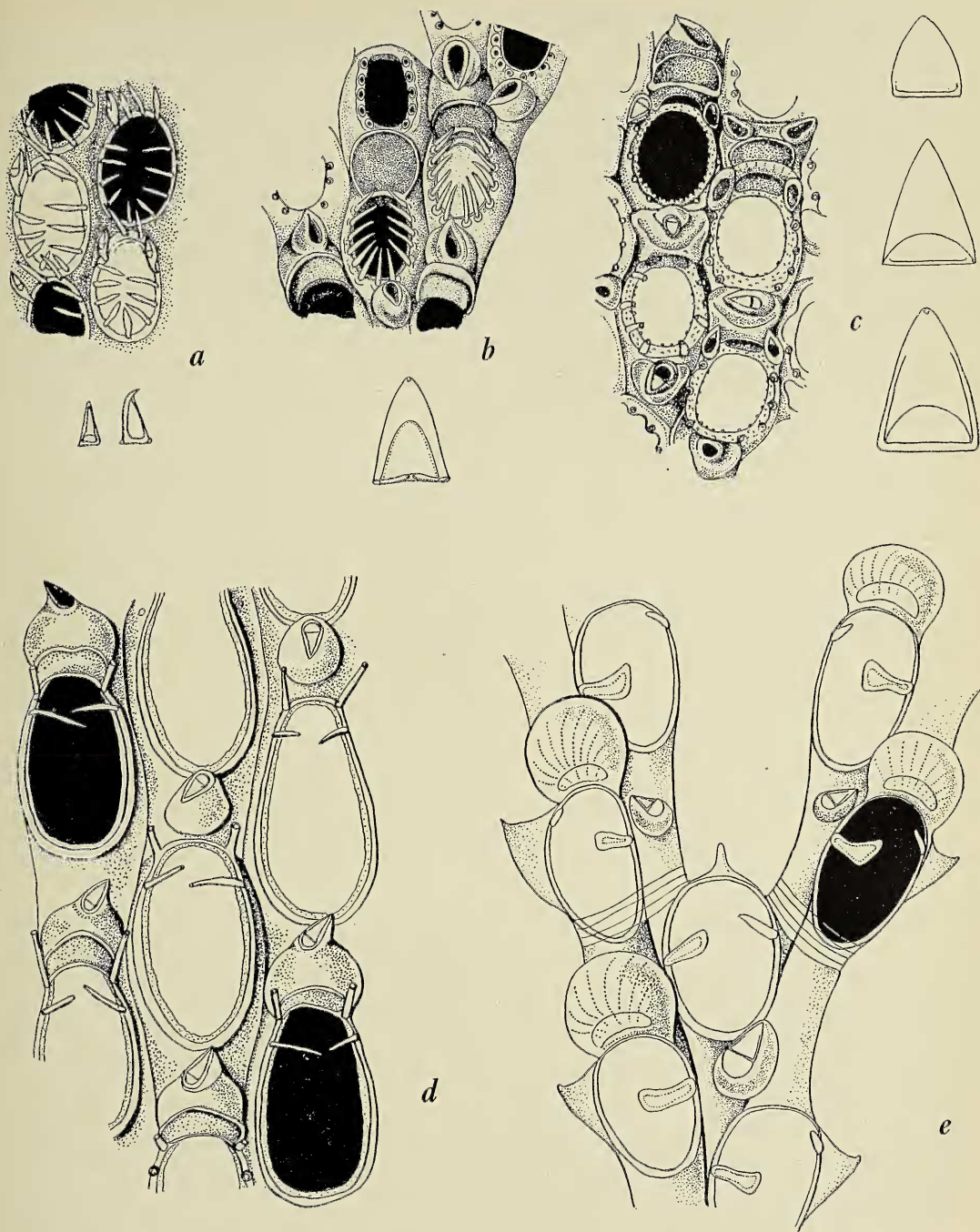


FIG. 4. *a*, *Cauloramphus spiniferum* (Johnston), frontal view of zoecia with spiniferous avicularia and minute mandibles of avicularia. *b*, *Callopora lineata* (Linnaeus), fertile zoecia with ooeccia superposed by frontal avicularia and detail of mandible of frontal avicularium. *c*, *Tegella armifera* (Hincks), frontal view of fertile zoecia and details of mandibles of frontal avicularia. *d*, *Tegella unicornis* (Fleming), matured zoecia and frontal avicularia. *e*, *Tricellaria erecta* (Robertson), frontal view of diverging branches.

12. *Tegella armifera* (Hincks), 1880

Fig. 4c

Zoarium encrusting, pale brown or grey. Zooecia large, distinct, separated by furrows. Gymnocyst about one-third or one-half of the frontal, convex, with large suboral avicularium on a prominent umbo. Opesia large, broad, with granular marginal cryptocyst and raised borders. Two or four opesial spines on each side, and a raised lateral avicularium on each distal corner. Ooecia globose, with flattened frontal surface limited by a transverse bar. Suboral avicularium close to the preceding ooecium. Two distal and four lateral multiporous rosette plates.

The direction of lateral avicularia and the full number of opesial spines differ from Osburn's description (Osburn, 1950), thus suggesting a distinct variety.

SPECIMENS EXAMINED: No. 4020 (Paramushir), No. 6320 (Kushiro).

13. *Tegella unicornis* (Fleming), 1828

Fig. 4d

Zoarium encrusting, irregular, yellow or brown. Zooecia regularly arranged, moderate with raised walls. Gymnocyst less than one-third of the frontal length. Opesia oval, narrowed distally with thickened margin and narrow cryptocyst minutely serrate; four spines near the distal end of opesia. Ooecia large, elongate, globose, with distinct transverse rib. Suboral avicularium comparatively large, prominent on an umbo, triangular mandible extending obliquo-proximally. Marcus suggested that Okada's specimens might belong to *T. robertsonae* but my reexamination has proved the correctness of Okada's identification.

SPECIMENS EXAMINED: No. 561 (Kamtschatka), No. 1403 (Alaid), No. 4214 (Samani), No. 6033 (Kushiro).

Family *MICROPORIDAE*14. *Microporina articulata* (Fabricius), 1821

Zoarium erect, dichotomously branching, articulated, Cellariiform, attached by rootlets. Internodes stout; zooecia around the zoarial axis, very elongated quadrangular, separated by furrows. Frontal flat, thick, minutely perforate and occasionally granulate, encircled by salient ridges. Opesia semicircular or semi-elliptic, with straight proximal border. Opesiules small, rather indistinct, slit-like. Avicularia oval, prominent, limited by salient ridges, immersed at the proximal end of the zooecium. Ovicells endozooecial.

SPECIMENS EXAMINED: No. 1409 (Alaid), No. 1425 (Paramushir), No. 6231 (Kushiro).

Family *SCRUPOCELLARIIDAE*15. *Tricellaria ternata* (Solander), 1786

Zoarium erect, white, bushy, expanded or confervoid. Branches straggling, internodes consisted of three to five zooecia. Chitinous joint traversing the base of both inner and outer zooecia proximally to the opesia. Zooecia slender, much attenuated below, with elliptic opesia. Scutum variable from a mere spine to spatulate plate. One or two inner and two or three outer spines on the distal margin. A small frontal avicularium on the axial zooecium. Lateral avicularium large and prominent. Ooecia large, globose rather elongate and imperforate. Radical fibres from a circular disc outside the opesia. Long claspers from a small chamber above the lateral avicularium, enlarged terminally.

SPECIMENS EXAMINED: No. 1410 (Alaid), Nos. 1422, 1436 (Paramushir), No. 6321 (Kushiro).

16. *Tricellaria erecta* (Robertson), 1900

Fig. 4e

Zoarium erect, with very long branches rather like that of *Scrupocellaria*. Zooecia biserial, attenuate proximally, with crenulate, raised margins and one or two spines at the outer corner. Scutum rather narrow, spatulate, occasionally broad and bifid; frontal avicularia generally on each zooecium, lateral avicularia



variable, often vestigial. Ooecia globose, striated and fenestrated. Joint traversing the base of the outer opesia.

SPECIMENS EXAMINED: No. 1419 (Paramushir), No. 4213 (Samani).

17. *Tricellaria unjoi* (Okada), 1918

Zoarium bushy, 2–3 cm. in height, milky white (in spirits). Branches delicate, biserial, internodes of three to five or five to nine zooecia. Zooecia elongate, narrowed proximally, with elliptic opesia. Two short spines on the outer opesia margin; scutum varying from a spinous process to a spatula. Marginal avicularia large, frontal avicularia wanting. Rootfibres from small chambers above the avicularia. Ooecia oval, globular, smooth with faint striations and peculiar elliptic median fenestra.

SPECIMEN EXAMINED: No. 565 (Kamtschatka).

18. *Scrupocellaria scabra* (van Beneden), 1848

Zoarium erect, bushy, stout. Internodes long, three to ten or more zooecia in a series. Joint traversing just proximally to the outer opesia or slightly involving it. Zooecia elongate, with curved outer margin. Opesia about half of the frontal length, oval, with developed cryptocyst and raised margin. Scutum very large, oval or flared, with branched internal cavity. A small inner spine and one or two outer spines on the distal corners. Marginal avicularia large, conspicuous on all of the zooecia. The frontal avicularia small, rather rare. Vibracula small, rather inconspicuous, transverse, above the avicularian chamber with transverse groove. Flagellum shorter than zooecia, somewhat stout, often wanting.

Ooecia subglobose, with striate triangular area on the front.

SPECIMENS EXAMINED: No. 1429 (Paramushir), No. 1211 (Akkeshi).

Family *BIALLARIELLIDAE*

19. *Watersia kishikaensis* (Okada), 1918

Fig. 5a

*Flustra episcopalis* var. *simplex* Okada (1917).  
*Flustra simplex* var. *kishikaensis* Okada (1918).  
*Euthyroides simplex* var. *kishikaensis* Okada (1921).

Zoarium erect, frondose, fan-shaped, bilaminar. Branches widened distally to the subtruncate end. Zooecia elongate-quadrangular, narrow; marginal kenozoecia much elongated. Orifice subterminal, broad, closed by opercular valve. Avicularia vicarious, elongate oval with radiating frontal striations and quadrangular base; mandible semicircular, broad.

Ooecia large, prominent, distinctly carinate, with paired elliptic fenestra and faint radiating lines.

SPECIMENS EXAMINED: No. 579 (Kamtschatka), No. 6290 (Kushiro).

20. *Bugula californica* Robertson, 1905

Zoarium erect, thick, bushy. Opesia about two-thirds of the frontal, with two to four short, stout spines on the distal corners. Avicularia large, robust, a little distal to the middle of the outer wall. Ancestrula with a median suboral spine and three or five distal spines. Ooecia unknown.

SPECIMEN EXAMINED: No. 4016 (Paramushir).

21. *Bugula* sp. undet.

Zoarium erect, bushy, delicate and small. Zooecia slender, with short proximal gymnocyst and truncate distal end. Opesia occupies the larger part of the frontal, with two outer and one inner spines on the corner. Avicularia small, rounded or elliptic, near the proximal end of the opesia on the outer wall. Ooecia globose, attached to the middle line. Rootlets numerous.

As the specimens are all fragmentary, the determination is postponed until more complete material is obtained.

SPECIMENS EXAMINED: No. 1207 (Akkeshi), No. 1428 (Paramushir).

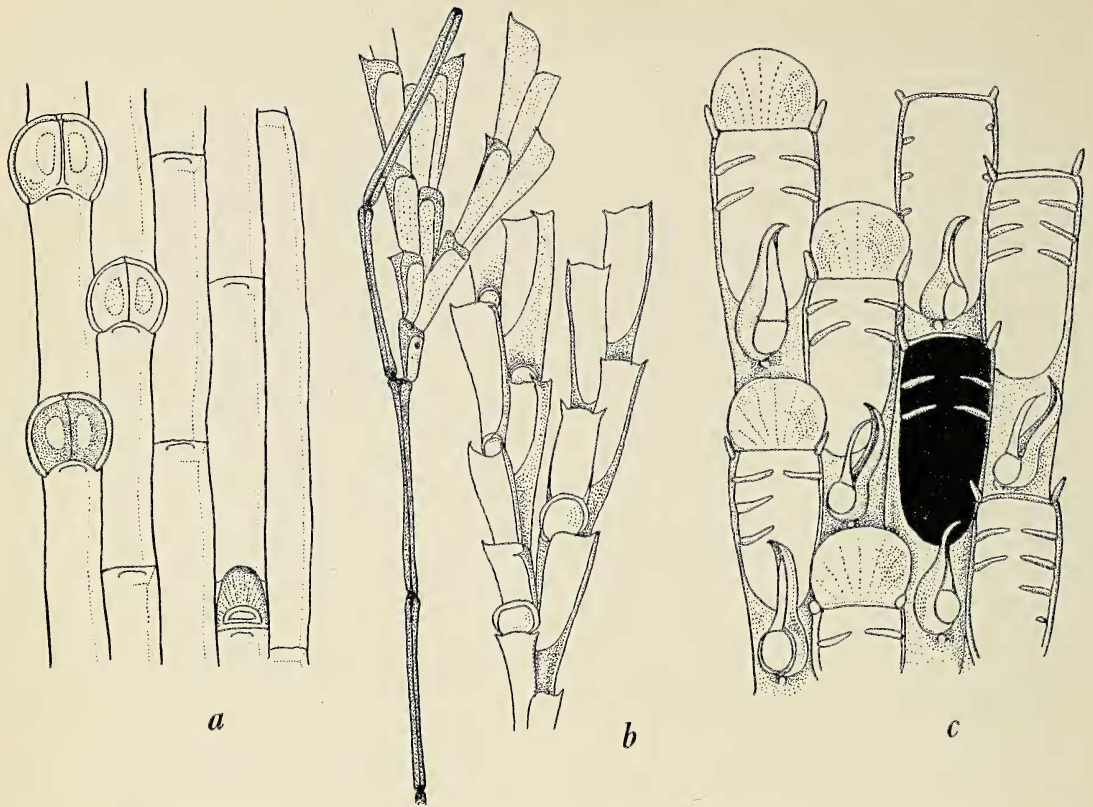


FIG. 5. *a*, *Watersia kishikaensis* (Okada), frontal view of marginal part of a lobate branch; elongated marginal kenozoecium, vicarious avicularium and fertile zoecia with carinate globose oecia. *b*, *Caulibugula aspinosa* n. sp., keel stem-kenozoecia, origin of functional branches and fertile internodes with ovicelled zoecia are indicated. *c*, *Dendrobeania kurilensis* (Okada), fertile part of an internode; striated oecia and long beaked frontal avicularia are figured.

## 22. *Caulibugula aspinosa* sp. nov.

Fig. 5*b*

Zoarium erect, biserial, delicate, bushy on a slender stem. Proximal kenozoecia of the stem elongate, tubular, strengthened by longitudinal ribs. Autozoecia elongate-quadrangular, attenuate below, truncate or a little oblique distally. Opesia large, occupying the large part of the frontal, without long spines but with a short process at each distal corner, sometimes wanting. Avicularia moderate, elliptic, on the proximal gymnocyst but rather rare. Oecia prominent, attached near the distal inner corner of the fertile zoecia.

The present species clearly belongs to

*Caulibugula*, but is rather peculiar inasmuch as it lacks long spines. The general form of the zoecial tuft is very close to that of *Bugula*.

SPECIMENS EXAMINED: No. 1402 (Alaid), No. 4512 (Reisui).

## 23. *Dendrobeania kurilensis* (Okada), 1933

Fig. 5*c*

*Bugula japonica kurilensis* Okada (1933).

Zoarium frondose, multiserial, without connecting tubes. Zoecia with a distal process and one to four spines on each lateral wall. Median proximal avicularia moderate, with peculiarly long, curved beak. Oecia mod-

erate. The long curved avicularian rostrum is peculiar.

SPECIMENS EXAMINED: No. 1407 (Alaid), Nos. 4228, 4519 (Monsei).

## ASCOPHORA

### Family HIPPOTHOIDAE

#### 24. *Hipbothoa hyalina* (Linnaeus), 1767

Zoarium encrusting, thin, hyaline, glistening or multilamellar, irregularly piled up, rough, opaque. Zooecia more or less separated, pyriform, convex, transversely ribbed, encircled by a row of fenestrae. Orifice terminal, circular, with rounded shallow sinus and thin peristome. Female zooecia a little smaller, male zooecia minute, occurring irregularly, with marginal perforations and branching suture.

SPECIMENS EXAMINED: No. 564 (Kamtschatka), No. 1418 (Paramushir), No. 4014 (Paramushir), No. 4217 (Samani), No. 4238 (Akkeshi), No. 6203 (Kushiro).

#### 25. *Hipbothoa expansa* Dawson, 1859

Figs. 6a-e, 7a, b

Zoarium thin, flat, flabellate or palmate, branched. Zooecia arranged in two or three rows, elliptic or pyriform, convex, with developed basal expansion and strong, transverse striations. Orifice subcircular, with broad shallow sinus closed by operculum (6e). Fertile zooecia shorter, with orifice straight proximally. Ooecium (6c) large, globose, broad, umbonate, thickened marginally. Operculum of fertile zooecium (6d) semi-circular, that of ordinary zooecia with proximal projection. Interesting connecting tubes (6b) are seen in optical section.

Occurrence of two types of opercula is the most striking feature to distinguish this species from *H. divaricata*.

SPECIMENS EXAMINED: No. 4007A (Paramushir), No. 6301 (Kushiro).

#### 26. *Hipbothoa divaricata* Lamouroux, 1821

Figs. 6f-b, 7c

Zoarium creeping, uniserial, branched, ramose, delicate. Zooecia elongate-pyriform, convex, very slightly striated with narrow basal expansion and longitudinal carina. Orifice rounded, with broad sinus. Fertile zooecium smaller, with similar orifice and operculum (6g) to those (6b) of ordinary one. Ooecia globose (6g), smooth, slightly umbonate. Zoarial arrangement and zooecial form somewhat variable. Because of these variations the varietal names *conferta* and *carinata* have been proposed.

SPECIMENS EXAMINED: Nos. 1431, 4007B, 4018 (Paramushir), No. 4212 (Samani), No. 1218 (Akkeshi), No. 6290 (Kushiro).

### Family PETRALIIDAE

#### 27. *Petraliella* sp.

Fig. 8a-c

Zoarium encrusting, thick, greyish white. Zooecia moderate, oval or hexangular, arranged alternately. Frontal convex, rather reticulate or ribbed with infundibular pores. Orifice and operculum (8b) very large, semi-elliptic or subquadrangular with straight lateral and proximal margins. A large, elliptic avicularium with semi-elliptic mandible (8c) on a salient suboral mucro.

The species resembles in general appearance *Cryptosula pallasiana* and *Petraliella armata*, but differs in the large orifice and semicircular mandible. The specimen is not complete, being without ovicells. It is tentatively referred to *Petraliella*.

SPECIMEN EXAMINED: No. 1427 (Alaid).

### Family SCHIZOPORELLIDAE

#### 28. *Stomachetosella sinuosa* (Busk), 1860

Figs. 8d, e, 9

Zoarium encrusting, circular, thick, dark reddish brown or brownish purple. Zooecia hexagonal or elliptic, with rather sinuate mar-

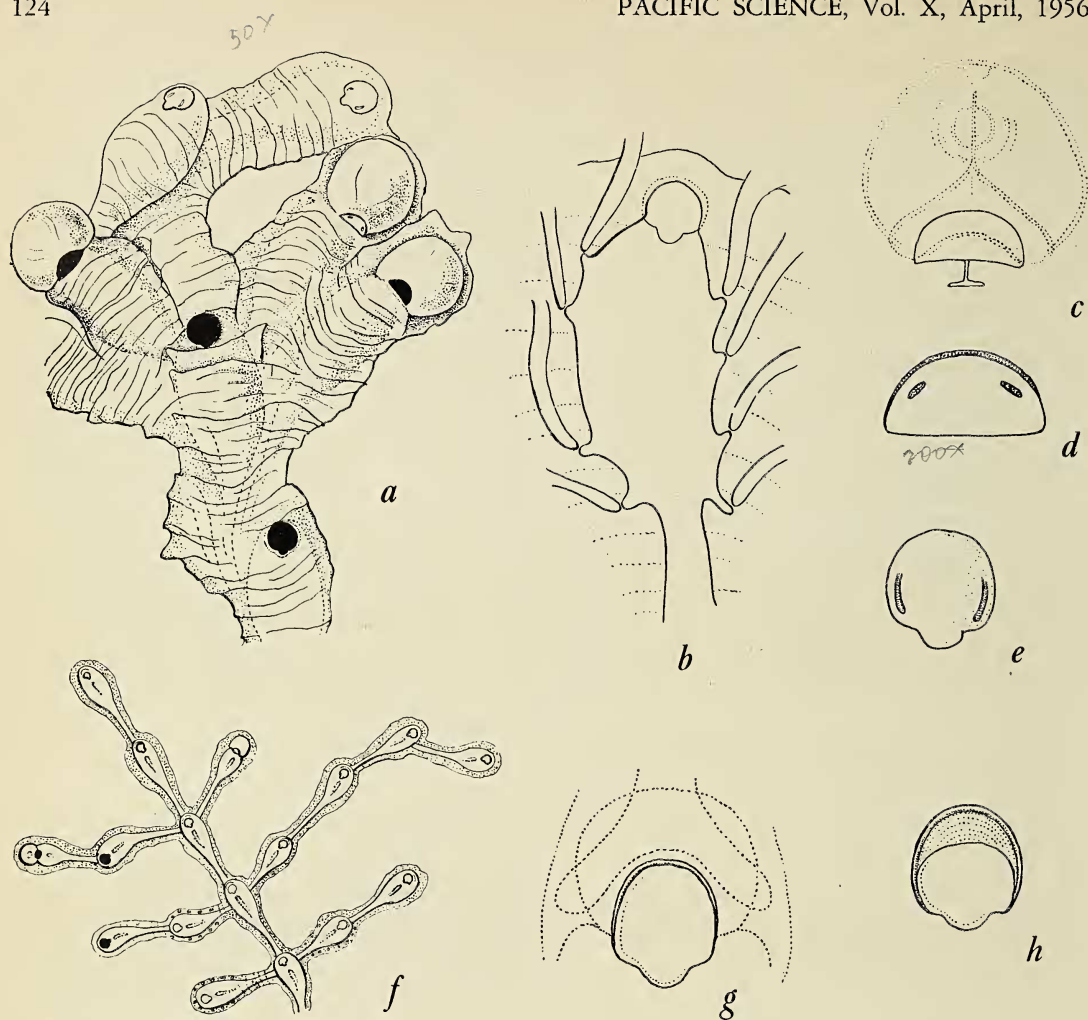


FIG. 6. *a-e*, *Hippotboa expansa* (Dawson): *a*, Part of an incrusting zoarium with semiglobular oecia; *b*, basal view of a zoecium, indicating the connecting tubes; *c*, structure of an oecium and aperture; *d*, operculum of a fertile zoecium; *e*, operculum of an immature zoecium. *f-h*, *Hippotboa divaricata* Lamouroux: *f*, Frontal view of a branching colony; *g*, structure of fertile zoecium with oecial cavity and the proximal end of the succeeding zoecium; *h*, operculum.

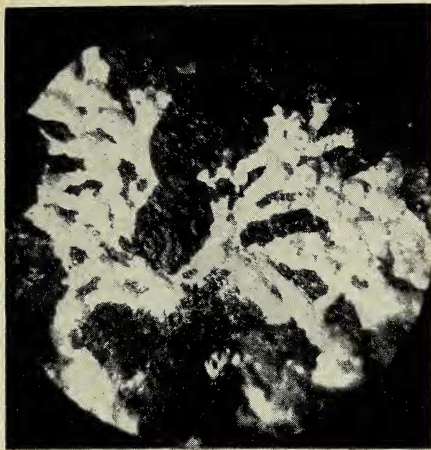
gin. Frontal thick, granular, convex or immersed, with large infundibular pores. Orifice circular or transversely elliptic with thin, pyriform peristome. No spines, no avicularium. Oecia large, deeply immersed, with circular median pore. Four lateral and two distal multiporous rosette plates, Operculum (8e) circular, with proximal projection and lateral muscular insertions.

This is the *Schizoporella sinuosa* of various authors.

SPECIMENS EXAMINED: No. 1421 (Paramushir), No. 4226 (Akkeshi).

## 29. *Umbonula arctica* (M. Sars), 1851

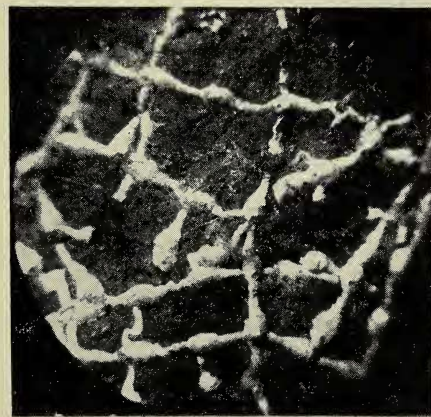
Zoarium encrusting or foliaceous, unilamellar or bilamellar. Zooecia large, oval, quinuncial, convex, elevated distally. Frontal ribbed, areolate. Orifice large, orbicular with low peristome and suboral small mucro. A small avicularium with rounded mandible on



a



b



c

FIG. 7. Photomicrographs of calcined specimens of: a, b, *Hippothoa expansa* Dawson; c, *H. divaricata* Lamouroux.

each side of the orifice. Ooecia large, globose, immersed.

SPECIMENS EXAMINED: No. 1400 (Alaid), No. 4012 (Paramushir), No. 4216 (Samani), No. 6305 (Kushiro).

30. *Schizoporella bidenkapi* Nordgaard, 1902

Figs. 8f, g, 9

Colony encrusting, circular, thick. Zooecia large, hexagonal or quadrangular, with salient separating threads. Frontal thickened tremocyst, granular. Immersed orifice transverse, elliptic, produced proximally. Peristome deep, with circular orifice. Operculum (8g) subquadrangular with arched distal margin and incomplete lateral sclerites. Two distal and four lateral rosette plates. Avicularia wanting or vestigial, immersed, with minute mandible (8g).

SPECIMEN EXAMINED: No. 4004 (Paramushir).

Family SMITTINIDAE

31. *Codonellina operculata* sp. nov.

Figs. 8b-k, 9

Zoarium encrusting, thin, irregular, white and shining or pale purplish brown. Zooecia elongate elliptic or hexagonal separated by salient threads, slightly convex, smooth, perforated by regular circular pores. Orifice sub-circular, with large sinus limited by broad cardelles, surrounded by thin peristome. Median suboral avicularium large, subquadrate, spatulate. Ooecium globular, perforate and marginate, bordered by peristome proximally. Operculum (8i) with submarginal short sclerites. Mandible (8j) with bifurcate median sclerite. Two distal and four lateral multiporous rosette plates (8k).

The species is allied to *Codonellina spatulata* (Okada and Mawatari), but is distinctly separated by its operculum and mandible.

SPECIMENS EXAMINED: No. 4015 (Paramushir), No. 4205 (Samani), Nos. 4219, 4517 (Akkeshi).

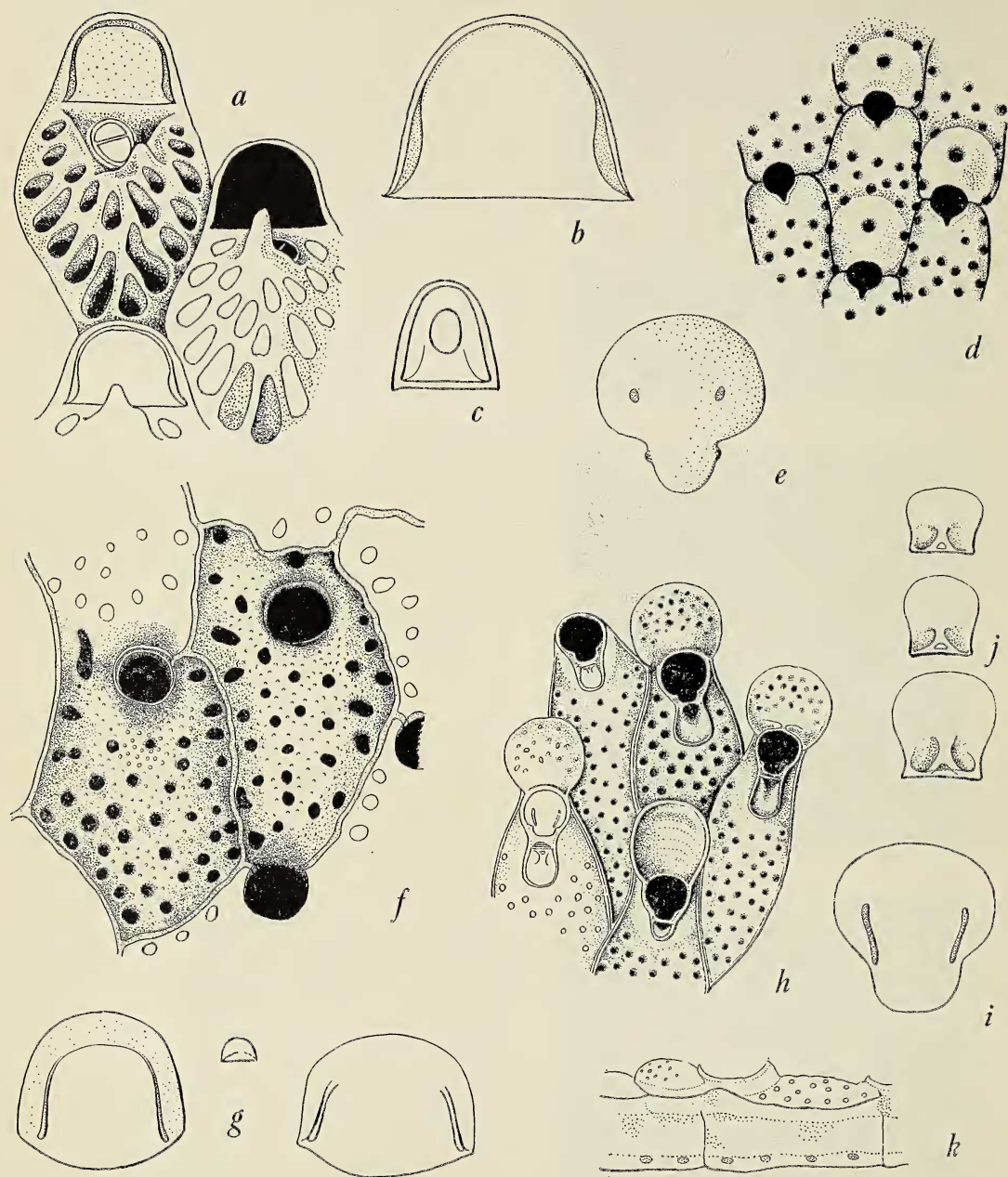


FIG. 8. *a-c*, *Petraliella* sp.: *a*, Frontal view of zoecia with subopercial process and an avicularium; *b*, operculum; *c*, mandible of the frontal avicularium. *d, e*, *Stomachetosella sinuosa* (Busk): *d*, Zoecia with perforated oecia; *e*, operculum. *f, g*, *Schizoporella bidenkapi* Nordgaard: *f*, Frontal view of zoecia; *g*, two opercula and a minute mandible of rare frontal avicularium. *h-k*, *Codonellina operculata* n. sp.: *h*, Frontal view of fertile zoecia with porous ovicells; *i*, operculum; *j*, frontal mandibles; *k*, lateral view of a zoecium.

32. *Porella mucronata* sp. nov.

Figs. 10a-d, 11a

Zoarium erect, branched, flattened or thickened, bilaminar or multilaminar. Zooecia large, oval or hexagonal, globose, becoming immersed with age. Frontal thick pleurocyst, with small number of deep areolar pores and submedian, suboral mucro supporting a circular avicularium. Orifice very large, semi-circular or subquadrangular, deeply immersed in the thickened peristome. Peristomial orifice with sinus. Ooecium globose, deeply immersed, opening into the peristome but not closed by operculum. Two lateral and one distal multiporous rosette plates. Operculum (10b) with strong lateral sclerites; mandible (10c) with marginal denticles. Large avicularian cavity is figured in section (10d).

The frontal pleurocyst, non-perforate ooecia, and suboral, submedian avicularia appear to me to indicate the position of the species near *Porella*.

SPECIMENS EXAMINED: No. 1413 (Alaid), No. 4210 (Samani).

33. *Porella immersa* sp. nov.

Figs. 10e-g, 11b

Zoarium disciform, dark brown or purple. Zooecia elliptic, subhexagonal, separated by furrows. Frontal convex pleurocyst, minutely granular with 8 to 13 small areolar pores. Orifice subcircular, with broad shallow sinus, concealed within a deep peristome. A small circular suboral avicularium on the raised frontal wall. Ooecia deeply immersed and concealed rather completely. Operculum (10e, f) subcircular with thickened margins and muscular insertions. Mandibles (10g) semi-circular with bifurcate median sclerite.

SPECIMENS EXAMINED: No. 4017 (Paramushir), No. 1209 (Akkeshi), No. 4207 (Samani).

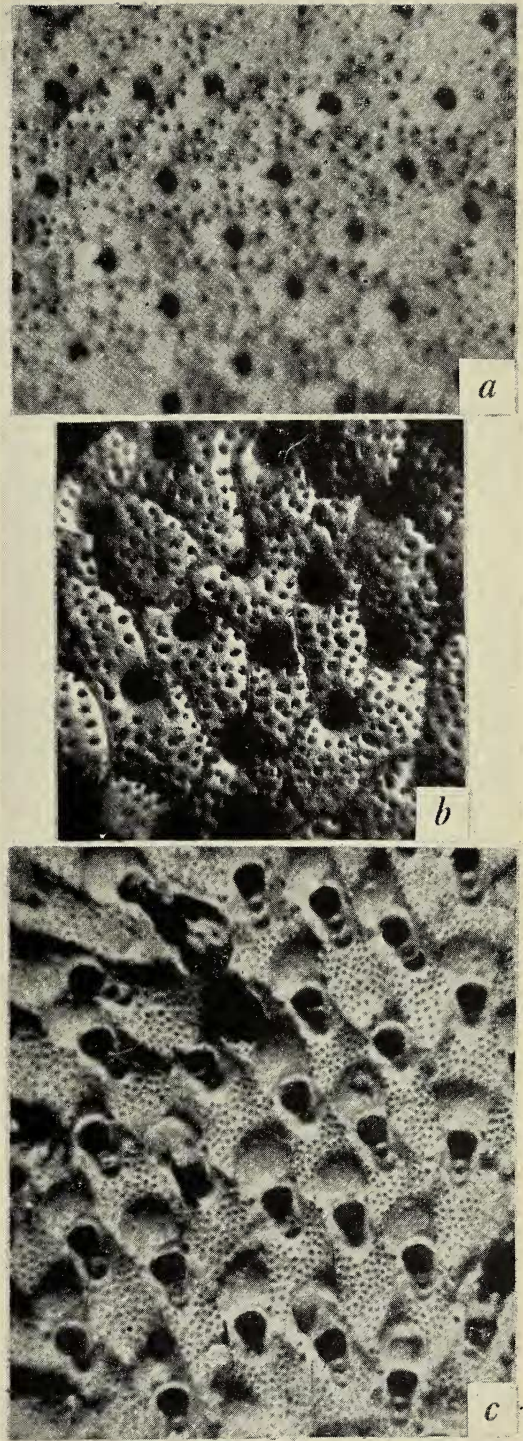


FIG. 9. Photomicrographs of calcined specimens of: a, *Stomachetosella sinuosa* (Busk); b, *Schizoporella bidenkapi* Nordgaard; c, *Codonellina operculata* n. sp.

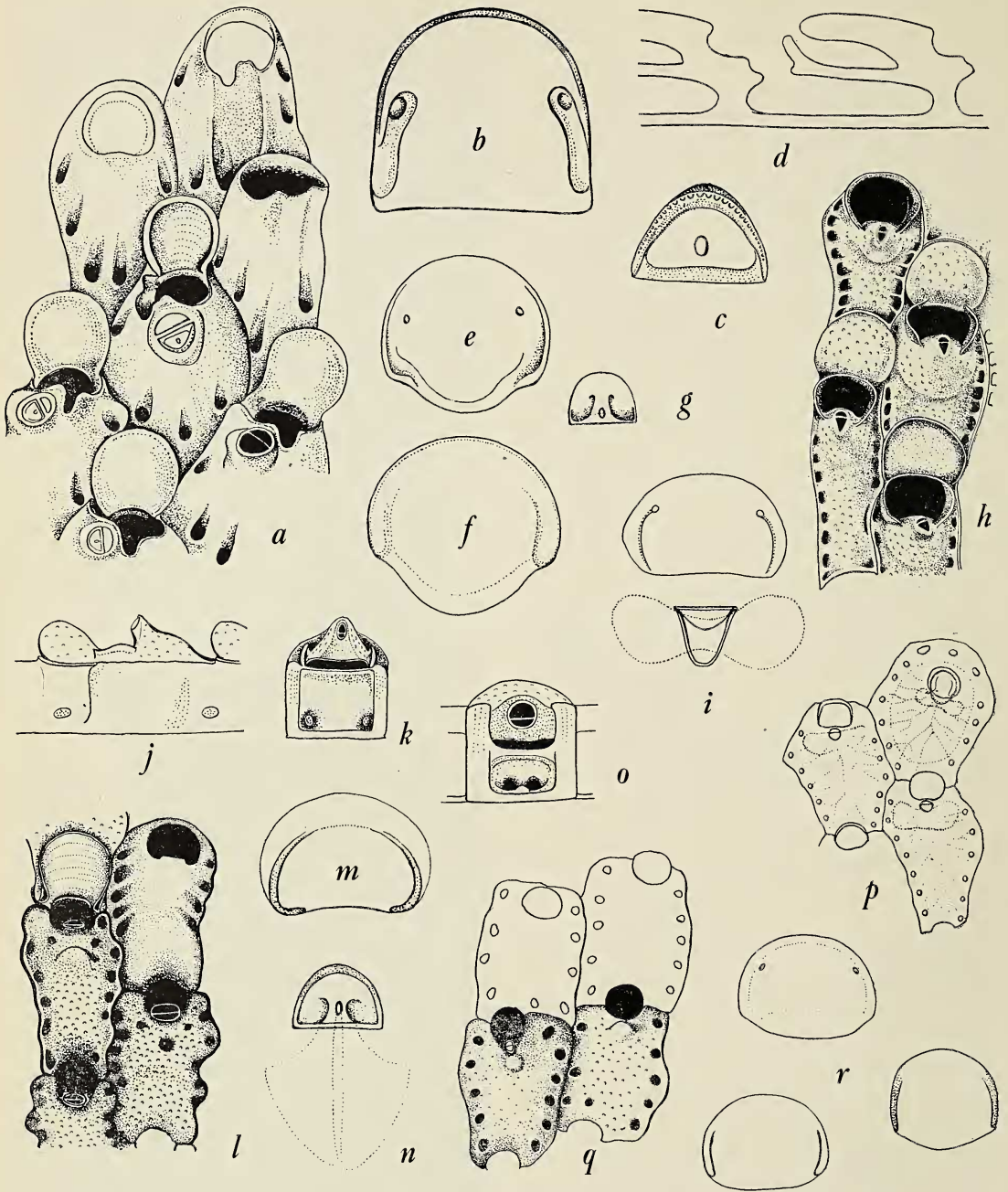


FIG. 10. *a-d*, *Porella mucronata* n. sp.: *a*, Frontal view of a part of the colony near the growing margin indicating the development of oecia and peristomes; *b*, operculum; *c*, serrated avicularian mandible; *d*, longitudinal section of zooecia and avicularia. *e-g*, *Porella immersa* n. sp.: *e*, Operculum of ovicelligeous zooecium; *f*, operculum of immature zooecium; *g*, mandible of the frontal avicularium. *b-k*, *Porella acutirostris* Smitt: *b*, Fertile zooecia and oecia; *i*, operculum, mandible and avicularian gland; *j*, lateral view of zooecia; *k*, distal view of a zooecium. *l-o*, *Porella concinna* (Busk): *l*, Frontal view of zooecia and oecia; *m*, operculum; *n*, mandible of a subopesia avicularium; *o*, distal view of a zooecium. *p-r*, *Porella kurilensis* n. sp.: *p*, Frontal view of young zooecia; *q*, calcified zooecia; *r*, opercula.



34. *Porella acutirostris* Smitt, 1867Fig. 10*b-k*

Zoarium encrusting, disciform, irregular. Zoecia elongate-hexagonal or oval, separated by salient threads. Frontal slightly convex, smooth or granular, with five to eight pairs of areolar pores, more or less reticulate in appearance. Orifice semicircular, somewhat straight proximally, surrounded by thin, raised, collar-like peristome. Avicularium is median, suboral, acute, on a prominent umbo including broad chamber (10*i*). Ooecia large, prominent, globose, granulate but imperforate. Two distal and two lateral multiporous rosette plates (10*j*, *k*). Operculum (10*i*) semicircular with muscular attachment. Mandible (10*i*) triangular, blunt, with thin marginal sclerite.

SPECIMENS EXAMINED: No. 575 (Kamtschatka), No. 4000 (Paramushir).

35. *Porella marukawai* Okada, 1918

Zoarium encrusting, unilamellar. Zoecia hexagonal or elongate-quadrangular, usually arranged in quincunx. Frontal wall thick, reticulate in appearance with shallow infundibuliform pores. Orifice nearly circular with shallow sinus limited with a pair of minute condyles. Orificial margin raised proximally into the suboral avicularian umbo supporting a small median avicularium with semicircular mandible. Ooecia large, globular, a little broader than long, distinctly descending proximally into the orifice. The surface divided by a transverse line, the proximal half with scattered pores of irregular shape and size.

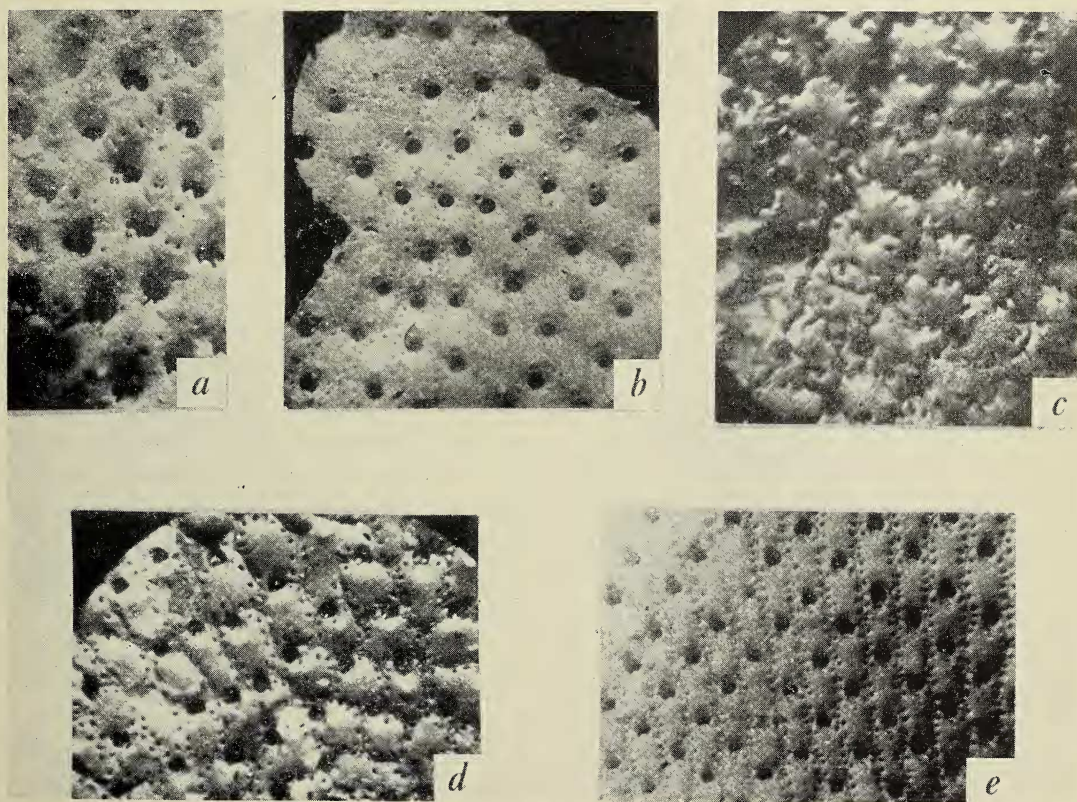


FIG. 11. Photomicrographs of calcined specimens of: *a*, *Porella mucronata* n. sp.; *b*, *P. immersa* n. sp.; *c*, *P. concinna* (Busk); *d*, *e*, *P. kurilensis* n. sp.

SPECIMEN EXAMINED: No. 572 (Kamtschatka).

36. *Porella concinna* (Busk), 1854  
Figs. 10*l-o*, 11*c*

Zoarium encrusting, thin, opaque. Zooecia ovate, convex, granular with areolar pores. Zooecial margin more or less sinuate. Orifice orbicular, more or less straight proximally, with distinct lyrula. Peristome thick, high, enclosing zooecial orifice at its bottom. A median suboral avicularium circular or elliptic, within the lower margin of the peristome, sometimes hidden by avicularian umbo. Ooecia globose, often half immersed, rarely with median pore. Operculum transversely elliptic with slightly concave proximal margin; mandible semicircular, typical with median fenestrae.

SPECIMENS EXAMINED: No. 4010 (Paramushir), No. 4208 (Samani), Nos. 4237, 4515 (Akkeshi).

37. *Porella kurilensis* sp. nov.  
Figs. 10*p-r*, 11*d, e*

Zoarium encrusting, irregular, thin, delicate. Zooecia quadrangular or hexagonal, granular, convex, five to eight areolar pores on each side. Orifice subcircular, transverse with concave, proximal margin. Peristome thin, slight. Avicularian umbo with transverse inner chamber just proximal to the orifice, supporting a circular or oval avicularium. A distal and two pairs of lateral pore-chambers with multiporous rosette plates. Operculum (10*r*) semi-elliptic, with incomplete marginal thickenings; mandibles minute, semicircular. Ooecia prominent, globose without perforations. The species is similar to some other *Porella*, but differs from them all in its operculum and mandibles.

SPECIMENS EXAMINED: Nos. 1424, 4010B (Paramushir).

38. *Smittina bella* (Busk), 1860  
Figs. 12*a-e*, 13

Zoarium moderately thick, encrusting, irregular. Zooecia hexangular, or elongate-quadrangular, convex, granular, punctured. Orifice semicircular or elliptic, transverse, at the bottom of the rather deep peristome with rounded orifice. A proximal median lyrula small, supporting an elliptic operculum. A suboral avicularium median, small, on the raised part with inner transverse cavity. Operculum (12*d*) elliptic. Mandible (12*e*) spatulate, quadrangular. Ooecia globose, immersed, not punctate. Two distal and four lateral rosette plates (12*c*) with narrow tubular passages (12*b*) are figured.

SPECIMENS EXAMINED: No. 1401 (Alaid); No. 1430 (Paramushir); Nos. 4003B, 4008B (Paramushir); No. 4218 (Samani); No. 6261 (Kushiro).

39. *Parasmittina trispinosa* (Johnston), 1825 var.

Fig. 12*f, g*

Zoarium encrusting, irregular, thin. Zooecia hexagonal or quadrangular with salient separating threads. Frontal smooth or granulate, slightly convex, with five to eight areolar pores. Orifice circular, imbedded in the shallow peristome, with lyrula and small cardelles (12*g*). Peristomial orifice circular often raised distally, with two or three distal spines. Avicularia oval, rather large with hinge bar situating laterally or proximally on the frontal. Operculum circular with nearly straight proximal border, mandible is spatulate, or semi-elliptic. The specimen at hand differs slightly from the typical species and from other known varieties.

SPECIMEN EXAMINED: No. 4003D (Paramushir).

40. *Mucronella peachii* (Johnston), 1847  
Figs. 12*b, 13*

Zoarium thick, disciform, pale brownish. Zooecia distinct, oval or hexagonal, convex, smooth or granular with prominent suboral mucro and small number of areolar pores.

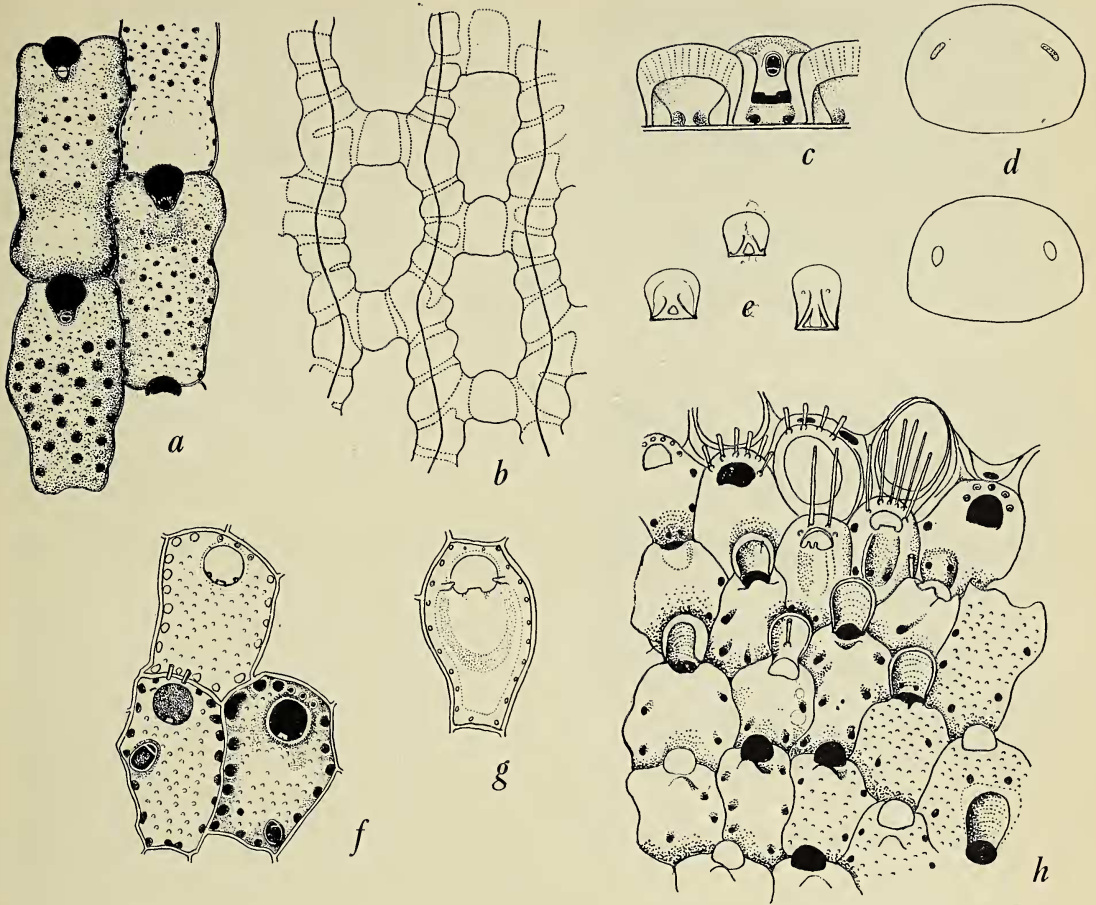


FIG. 12. *a-e*, *Smittina bella* (Busk): *a*, Zoecia with immersed oecia; *b*, basal view of zoecia indicating communication system; *c*, distal view of zoecia; *d*, opercula; *e*, mandibles of peristomial avicularia. *f*, *g*, *Parasmittina trispinosa* (Johnston) var.: *f*, Frontal view of young zoecia; *g*, internal aspect of a zoecium. *h*, *Mucronella peachii* (Johnston), frontal view of the growing margin of a colony indicating the development of the oecia, forming of the peristome and the disappearance of the spines.

Orifice semi-elliptic, rather large, straight proximally, with median lyrla. Peristome developed, thick, covering the orifice. Six spines on the distal border of the orifice, long, articulated basally. A longitudinal depressed area at the middle of the frontal, later covered by mucro. Two distal and four lateral multiporous rosette plates. Oecia globose, half immersed.

SPECIMEN EXAMINED: No. 4003A (Paramushir).

#### Family RETEPORIDAE

#### 41. *Schizoretepora tumescens* (Ortmann), 1890

Fig. 14a-g

*Retepora tumescens* Ortmann (1890).

Zoarium of usual *Reteporella* type, rather thick, with small elliptic fenestrae. Zoecia facing internally to the cup-shaped colony, elongate-hexagonal, convex, granulate, with

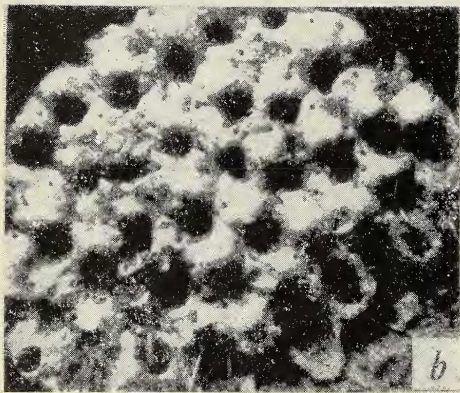
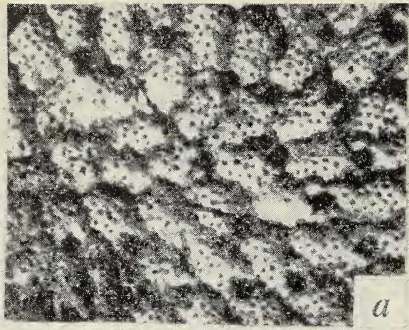


FIG. 13. Photomicrographs of calcined specimens of: *a*, *Smittina bella* (Busk); *b*, *Mucronella peachii* (Johnston).

two to five small pores. Orifice circular, with shallow sinus. Peristome thin collar-like in younger stage (14*c*), thickened with age (14*a*), sinuate or bilobed proximally. Frontal avicularium large, prominent, raised on the mucronate process, with curved end. Ooecia globose (14*b*), distinctly sinuate frontally, smooth. A pair of spines on the distal corner of the peristome. Dorsal vibices (14*e*) salient, limiting elongate quadrate or irregular area. Dorsal avicularia small, elliptic, acute, variable in number. Fenestral perforations rather constant. Operculum (14*f*) subcircular with marginal thickening, mandible (14*g*) triangular, elongate, sometimes with gland, those of dorsal avicularia minute but of the same shape.

SPECIMENS EXAMINED: No. 4009B (Paramushir), No. 4215 (Samani).

#### Family CELLEPORIDAE

##### 42. *Siniopelta costazii* (Audouin), 1826

Zoarium encrusting or discoidal mass. Zooecia decumbent, erect, irregularly crowded. Orifice suborbicular with long sinus, deeply immersed within the peristome. Peristome salient, with erect avicularian processes laterally. Interzooecial avicularia large, scattered, with spatulate mandible. Ooecia decumbent, rounded, broad, with perforated area.

SPECIMENS EXAMINED: No. 1414 (Alaid), No. 1433 (Paramushir), No. 4210 (Samani), No. 4224 (Akkeshi), No. 6288 (Kushiro).

##### 43. *Siniopelta incrassata* (Lamarck), 1856

Fig. 15*a-e*

Zoarium nodulous. Zooecia large, decumbent or erect, piled up in older stage, porous. Zooecial orifice circular with sinus rather longer than wide. Peristome thick, developed; orifice circular, sinuate, with small lateral avicularia on a projection. Ooecia moderate, decumbent, globose, smooth, with perforated frontal. Operculum (15*b*) oval with proximal lip, mandible of dependent avicularium (15*e*) is small, semi-elliptic. Vicarious avicularia occur in two forms, elliptic or circular, with spatulate (15*c*) or semicircular (15*d*) mandibles.

This species is here transferred from *Cellepora*.

SPECIMENS EXAMINED: No. 4020B (Paramushir), No. 4202 (Samani), No. 4231 (Akkeshi), Nos. 6255, 6311 (Kushiro).

#### Family MYRIOZOIDAE

##### 44. *Myriozoum subgracile* d'Orbigny, (1852)

Fig. 15*f-i*

Zoarium erect, tubular, branched, ramose. Zooecia arranged radially around the axis, not distinctly separated. Frontal (15*f*) slightly convex, perforated. Zooecial cavity (15*b*)

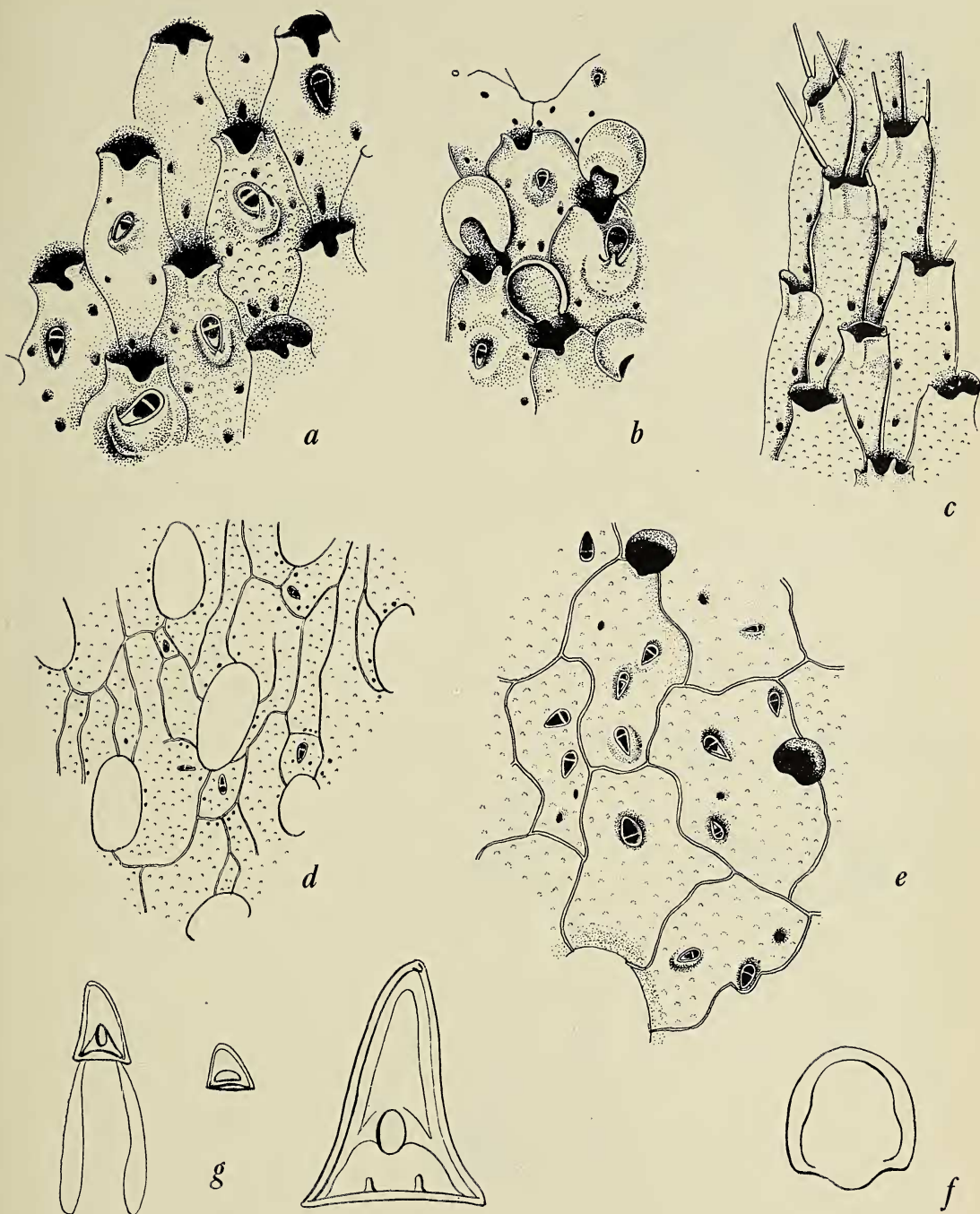


FIG. 14. *Schizorettopora tumescens* (Ortmann): *a*, Frontal view of completed immature zooecia; *b*, fertile zooecia with developing oocysts; *c*, young zooecia near the growing margin; *d*, basal view of a colony; *e*, basal kenozoecia with basal avicularia; *f*, operculum; *g*, small mandible with avicularian glands and mandible of a gigantic frontal avicularium.

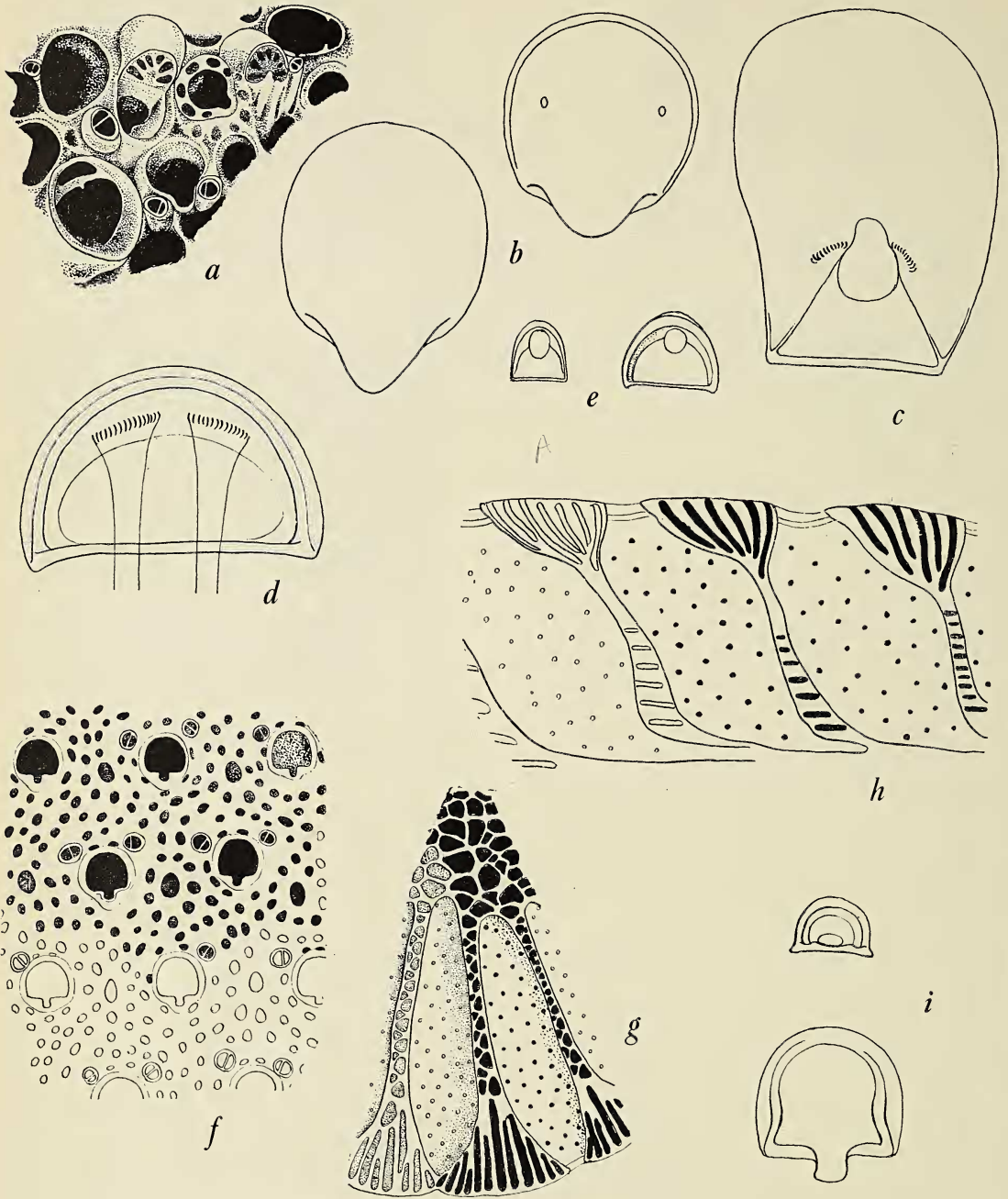


FIG. 15. a-e, *Siniopelta incrassata* (Lamarck): a, Frontal view of a part of the colony; b, opercula; c, mandible of a spatulate avicularium; d, mandible of a large vicarious avicularium; e, mandibles of the frontal avicularia. f-i, *Myrionozoum subgracile* d'Orbigny: f, Frontal view of a branch; g, transverse section of a branch; h, longitudinal section of a branch showing numerous communication pores piercing the walls; i, operculum and mandible.

deep, communicated by pore-tubes (15g) in all directions. Orifice semi-elliptic, with narrow sinus, surrounded by low peristome. Ooecium deeply immersed, obscure in frontal view. Avicularia circular or elliptic, with hinge bar on each distal side of peristome, single or paired. Operculum (15i) semi-elliptic, with strong submarginal sclerite and proximal lip. Mandible (15j) semicircular with fenestra.

SPECIMENS EXAMINED: No. 4021B (Paramushir), No. 4206 (Samani).

45. *Myriozoella planum* (Dawson), 1859

Zoarium encrusting, uni- or multi-lamellar. Zooecia distinct, slightly convex, distinctly or indistinctly separated. Frontal thick, perforated rather coarsely. Orifice semicircular, with sinus and thickened low peristome. A rounded or elliptic avicularium on each side of the orifice, without hinge bar. Operculum semicircular with marginal sclerite and proximal projection. Mandible semi-elliptic with incomplete marginal sclerite. Ooecia immersed, distinct with marginal pores.

SPECIMENS EXAMINED: No. 1423 (Paramushir), No. 1404 (Alaid), No. 6262 (Kushiro).

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